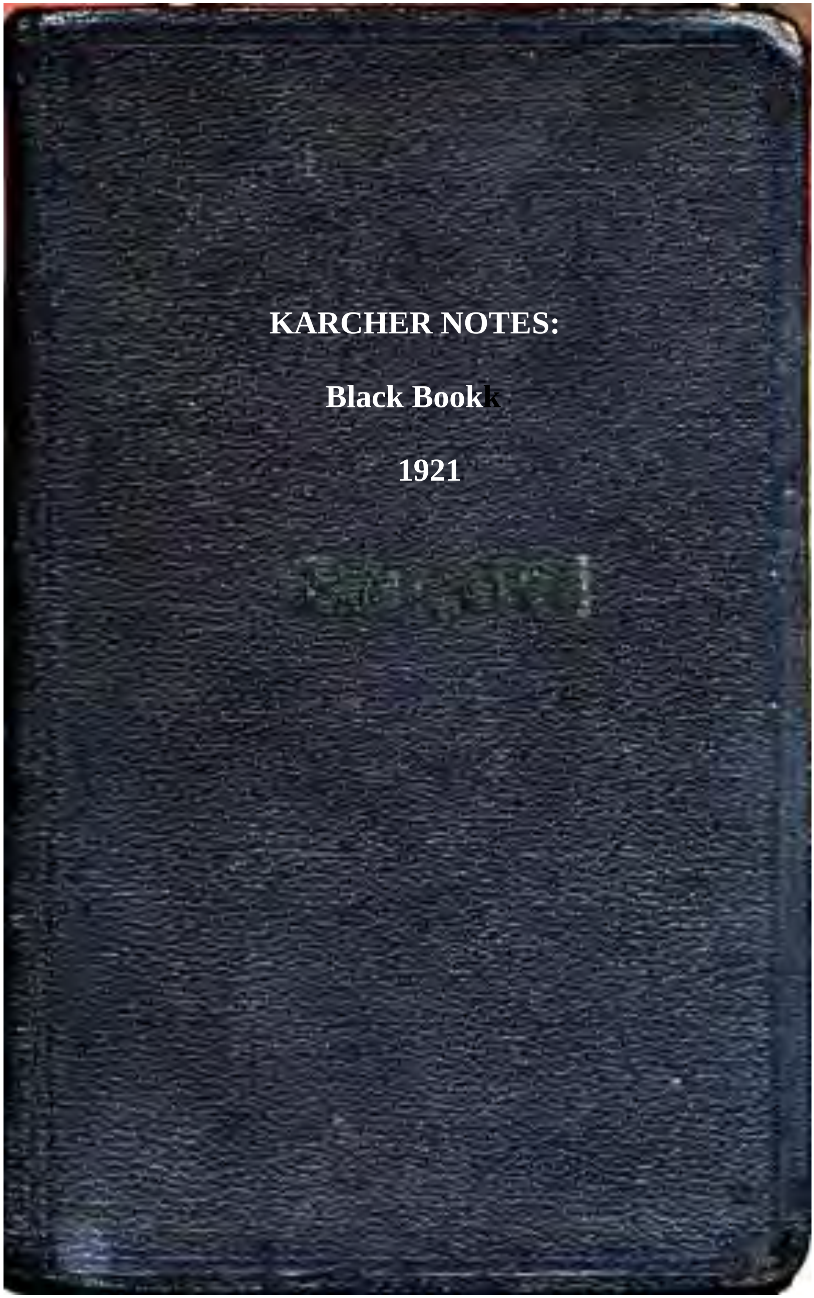


KARCHER NOTES:

Black Bookk

1921

J. C. Tucker.
17 Glen Ridge Parkway
Montclair N.J.

CORE LABORATORIES, INC

DALLAS

COMPANY [illegible] DATE [illegible] FILE [illegible]

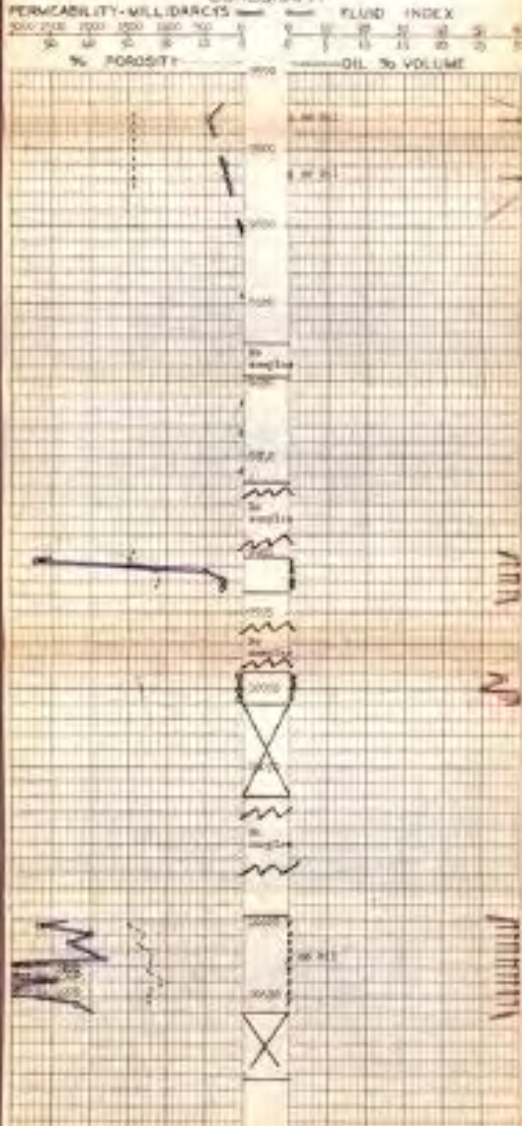
WELL [illegible] MILEAGE

FIELD [illegible] FEET ANALYZED

COUNTY [illegible] ANALYSTS [illegible]

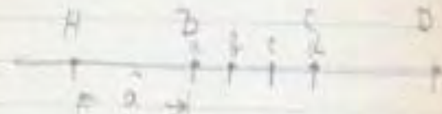
COPIES [illegible] TO TO

COREGRAPH



New York
Feb. 20, 1928

Modification of 4 electrode method.



According to Wenner the apparent resistivity is

$$\rho = 2\pi a \frac{V}{I}$$

where I is current flowing thru ground circuit A D and V is potential between B and C.

When taking measurements with electrodes a b c d the effect of the insulating layer

is smaller than when
resistivity measurements between the
electrodes A B C D.
If the geological structure [illegible]
is substantially homogeneous
the ratio of the apparent conductivity
S/S'' is a function of the depth.

Emmett to St Louis
May 15th 1925

Transmission of Radio waves
thru the earth.

$$H_x = H_0\, e^{-\left(\sqrt{\frac{2\pi \omega \mu}{\rho}}\right)x} \; {}^{*} \quad \text{or}$$

$$\frac{H_x}{H_0} = e^{-\sqrt{\frac{4\pi^2 f \mu}{\rho}}\, x}$$

$$= 10^{-2.724\sqrt{\frac{f}{10^9 \rho}}}\, x$$

where f = frequency in c.p.s.
ρ = resistivity in ohms/cm^3
x = depth of penetration in cm
H_x = intensity of Magnetic field at x
H_0 = " " " " at surface

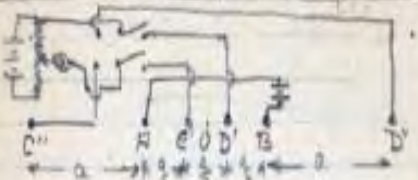
λ (meters)	f (c.p.s.)	ρ (ohms/cm^3)	x (meters)	H_x/H_0	H_x/H_0
3.	10^8	2000	100	10^{-193}	
20000	15,000	2000	100	$10^{-2.73}$	.00425
3	10^8	2000	10	$10^{-19.3}$	
20000	15000	2000	10	$10^{-.273}$	.57
3	10^8	20000	100	10^{-61}	
20000	15000	20000	100	$10^{-.75}$	.178
20000	15000	20000	1000	$10^{-7.5}$	.00000031
3	10^8	20000	1	$10^{-.61}$	.25
100000	3000	20000	1000	$10^{-3.34}$	.00044

also $\frac{X_a}{X_b} = \sqrt{\frac{\lambda_a}{\lambda_b}}$

* Principles of Radio Communication – Morecroft – p 744

Ewirt & Rollins
May 16th 1935

Six Electrode Electrical Method



Consider an electrode arrangement of six electrodes C'' A C' D' B D''

Using electrodes A and B as current input electrodes and C' and D' as potential electrodes an apparent resistivity of the material near the surface is obtained thus

$$\rho' = \frac{2}{3}\pi a \frac{V'}{I'}$$

Using electrodes C'' and D'' as input electrodes and A and B as potential electrodes a similar relation is obtained for the larger spread

But the same effect will be obtained if A and B are used for current input electrodes and C'' and D'' as potential electrodes i.e.

$$\rho'' = 2\pi a \frac{V''}{I''}$$

The advantage of using the electrodes A, B as current electrodes in

the second case reduces the length of power cable required to 1/3 of that when C'', D'' are used as current electrodes also it permits both measurements to be made without changing power connections.

As mentioned on page 4 the depth P

$$P = f\left(\frac{\rho''}{\rho'}\right)$$

By using the seventh electrode O as a potential electrode measurement of potentials between O and C'' and O and D'' will show any asymmetrical condition.

solving for K

$$K = \frac{4}{2}\left[\left(\frac{V_a}{V_0}\right)^2 - \frac{V_a}{V_0}\right]$$

Bakersfield Calif
May 25, 1925

Determination of Depth by Reflection
Using average velocity as a function of depth

where

$$V_a = V_0\sqrt{1+KZ}$$

then since approximately

$$V_0 t = \sqrt{X^2+Z^2}$$

$$V_0\sqrt{1+KZ}\,t = \sqrt{X^2+Z^2}$$

$$V_0^2(1+KZ)t = X^2+Z^2$$

from which

$$Z = \frac{-V_0^2t^2K \pm \sqrt{V_0^4t^4K^2 - 4(X^2-V_0^2t^2)}}{2}$$

 Current in Cycles

Electrical Survey Eastland County
Near well in NW Cor Sec 3 H&TCRR
Block 1

a	I/V	ΔI/V	ρ	depth
0	0		7250	75
50	1.32		5100	150
100	3.12		6610	225'
150	4.57		10300	300
200	5.50		1570	375'
250	6.96		4300	450
300	7.15		3690	525'
350	11.75		2950	600
400	14.17		2430	675'
450	18.75		1870	750
500	23.20		1920	825'
550	28.6		2250	900
600	32.5'		2590	975'
650	36.2		1520	1050
700	42.5'		1550	1125'
750	45.7		1630	1200
800	54.5'		1570	1275'
850	10.6		1240	1350
900	15.0		1180	1425'
950	73.7		1810	1500
1000	77.5			

Electrical Survey Eastland County
about 2 miles east of well location given on left page

a	I/V	ΔI/V	ρ	D
0	0	5.35'	1790	75'
50	5.35'		1730	150
100	11.9		1630	225'
150	17.8		1920	300
200	22.5		1920	375'
250	27.5		1580	450
300	33.1		1600	525'
350	(29.5?) 36.5		2820	600
400	42.5'		2400	675'
450	46.5'		1580	750
500	51.6		1960	825'
550	56.5		2920	900
600	59.9		1410	975'
650	66.7		1410	1050
700	76.5'		2040	1125'
750	78.2		1840	1200
800	82.4		1455	1275'
850	90.0		912	1350
900	100.5'		1010	1425
950	110.0			
1000				

Electrical Survey Coleman Co Texas
East of Santa Anna Field (about 1 mi E)

a	I/V	δI/V	ρ	D
100	2		9500	75
200	5		1330	225
300	7		9500	375
400	11		4770	525
500	16		3800	675
600	25		2160	825
700	36		2160	975
800	47		1730	1125
900	57		1590	1275
1000	76		1120	1425
1100	89		1470	1575
1200	100		1730	1725
1300	101		1900	1875
1400	120		1000	2025
1500	120		1900	2175
1600			1590	2325
1700			1900	2475
1800			9500	2625
1900			1730	2775
2000			2120	2975

Electrical Survey Coleman Co Texas
Thru Santa Anna field (N & S)

Torsion Balance
Beam suspended at 5:45 PM

Time	R	
5:50	-2.0	
6:04	-2.95	
6:20	-4.20	
7:00	-4.7	
7:20	-5.0	
8:00	-5.7	
~~8:05~~	—	arrested and released balance
8:15	-5.1	
8:30	-5.3	
8:32	—	Arrested rotated 180° and released.
9:00	-6.6	
9:30	-7.2	
9:32	—	Arrested, Rotated to 0° & Released
9:43	-1.5	
9:45	—	Arrested Rotated to 180° & Released

New York N.Y.
Nov. 2, 1925

On a method of making explorations with Radio waves.

Because of the absorption of radio waves in absorbing media, there is a substantial reduction in velocity of propagation.

The result is that the wave length is shortened therefore it should be possible to focus waves in conducting media where waves of the same frequency are too long to be focused in air.

One report ~~states that~~ waves in the earth travel with a speed about 1/40 ~~that~~ in air, which would mean ~~that~~ waves. For frequency of $3 \cdot 10^6$ c.p.s. would have a wave length of 100 meters in air and about 2½ meters in earth. Waves as short as that can be easily focused.

New York, Dec 21 1925

Heretofore workers who have attempted to transmit radio waves into the earth and observe their reflection have attempted to use very short waves.

This was done in order to be able to focus these waves and secure a beacon which was to be ~~transmit~~ directed into the ground and the reflection observed.

The writer proposes to use long waves and secure the desired results because with long waves it is possible to transmit the waves into the earth to far greater depths than is possible with short waves.

The depth of penetration varies as

$$\frac{X_{\lambda_1}}{X_{\lambda_2}} = e\sqrt{\frac{\lambda_1}{\lambda_2}}$$

Thus the penetration of a 1000 meter plane wave is e^{10} times as great as for a 10 meter plane wave. It is over 22000 times as far. (see – Morecroft, Principles of Radio Communication p 844)

By using a Beam transmitter such as that described by Dellinger &

H Pratt. Proc I.R.E. Vol 16 pp 890-920 July (1925.) It will be possible to make subsurface station

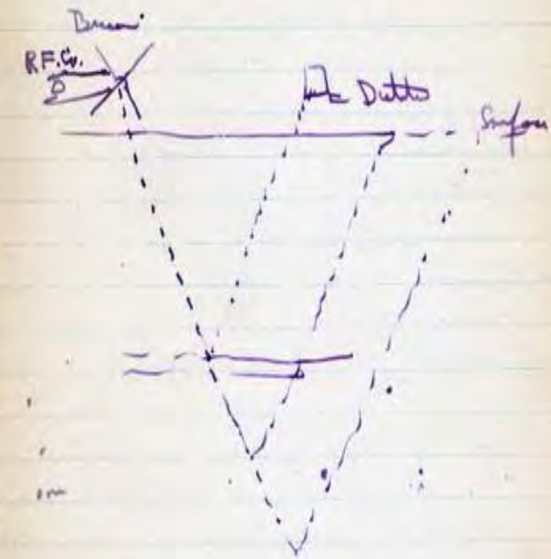
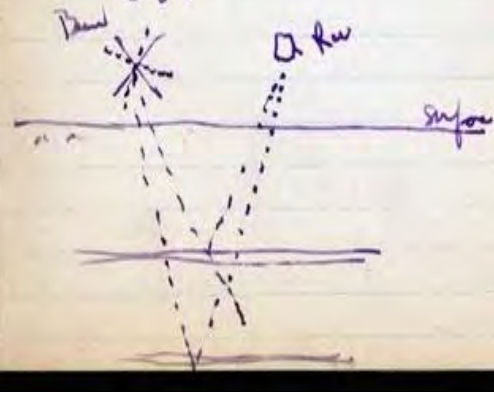


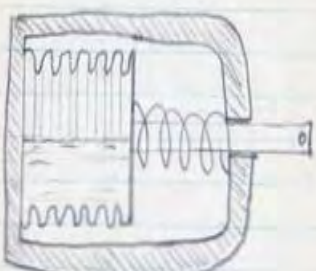
Fig 1



New York Jan 8 1930

Vapor Pressure Temperature Regulator.

Use a metal Bellows containing Ether hermetically sealed



Use Bellows 2½" diam, [illegible] Ether and [spring] initial [illegible] compression 135 lb. and increase at rate of 45 lb per inch so final [illegible] is 180 lb.

Pentane boils at 37°C @ 760 mm
Hexane " " 69°C " " "

Vapor Tension Various Liquids (Pressure in Lb/□")

Temperature °C	Temperature °F	Water	Carbon Disulphide	Carbon Tetrachloride	Chloroform	Ethyl Alcohol	Ethyl Ether	Acetone
0	32°		2.5		1.15		3.54	----
10	50°		3.24		2.03		5.55	
20	68		5.76		3.10		8.36	
30	86		8.40		4.78		12.27	
40	104		11.94		7.14		17.53	
45	113		14.1		8.62		20.75	
50	122		16.57		10.34		24.45	
55	131		19.63		12.33		28.65	
60	140		22.52		14.6		33.35	
65	149		26.02		17.2		37.62	
70	158		30.00		20.8		45.54	
75	167		34.40		23.48		51.18	
80	176		39.30		27.20		60.50	
90	194		50.60		36.03		75.31	
100	212		64.30		46.90		95.90	

Dimensions of Patent office drawings

St Louis Jan 27 1930

Electrolytic Geophone.

An electrolytic geophone may be constructed by using metal electrodes one (b) suspended relative to the other (c) by means of a spring (d) and the two electrodes immersed in an electrolyte e.

Try space between electrodes .5 mm

Try silver electrodes and silver cyanide solution or maybe better salt with low velocity ions.

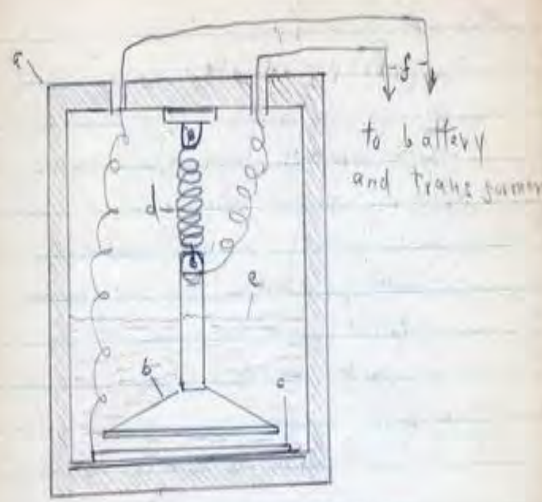
Look up electropositive and electronegative list of metals.

Maybe gold best of all

All exposed metal parts inside case should be plated with same metals as electrodes

With solution to give 0.5 amps at 1.5 volts and transformer feeding grid 2 to 1 step down, movement of .001 mm should produce grid current of about .001 amps and produce 10 mm defl or overall amplification of 1,000

St Louis Jan 27 1930



Gold - gold chloride - gold may be stable if hydrogen is not liberated when potential across electrodes is raised.

Probably best results with most electronegative metal. that is a potential + or - on ions of electropositive metals will probably displaced by electronegative ions.

Also consider metal least likely to cause liberation of hydrogen at higher voltages.

Device appears to be many times more sensitive than magnetophone.

St Louis Jan 27 1930

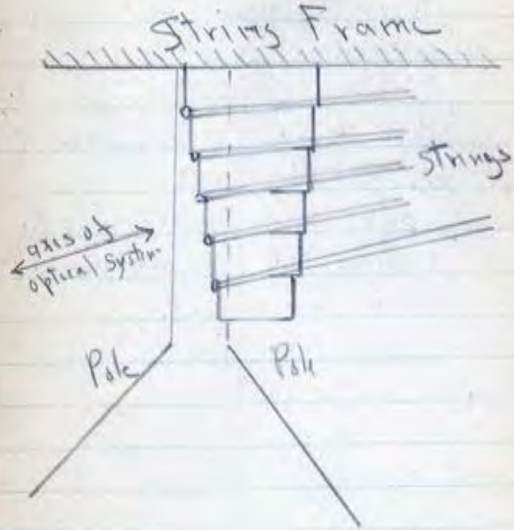
A String Galvanometer

Pull strings over step spool (made of ivory) which is mounted against face of String Frame.
String Frame to set against face of magnets and guided into place by slipping over two guide studs which also serve to hold Frame in place.

Magnification 20X

distance between strings 0.20"
distance " " images .6"
stagger .006"
diam strings 0.02
" " images .040
distance between poles .0625"
width of poles .156"
length of poles 3."
" " strings 6".
focal length lens (use microscope [illegible]
5/8" (1.5 cm)
distance lens to screen 12½"
Mount on rubber shock absorber.

1



Use ribbon with a half turn twist
width .003" thickness .0005
r = .8 ohm per inch

Mfrs of String Galvanometers
General Radio Co Cambridge Mass
Leeds & Northrup [illegible]
Cambridge Instrument Co Grand Central Terminal N.Y.

New York
Jan 29 1950

Specific Resistance of various electrolytes at 18°C
1. Normal solution contains 1 gm mol wt per liter of water.

Substance	Concentration .001	.01	.1	gm mol wt
Na Cl	9400	980	108.7	58.45
K CL	7880	816	89.3	74.55
Ag NO$_3$	8840	967	106.1	169.9
Zn SO$_4$	10140	1372	220.1	161.44
Cu SO$_4$	10150	1395	228.	159.63
Mg SO$_4$				120.38

No data on Mg but may be one of best with low Metal over voltage and high electrolyte over voltage It is very electronegative.

Electrode potential with reference to H

Lithium	-3.022	Cu	+.3448
Magnesium	-1.866	Ag	+.7986
Zn	.7581		
Pb	.1215		

Metal over voltages are in Normal sulphate solutions at a current density of .01 amp per sq cm. ~~Oxygen~~ Hydrogen overvoltage is ~~over~~voltage required to liberate ~~Hydrogen~~ Oxygen at the surface

Metal	Cathode over voltage	Anode overvoltage	Hydrogen overvoltage	Oxygen
Silver	0.07	- - -	.298	
Lead	0.00	- - -	.52	
Zn	0.02	0.01	.716	
Cu	0.02	0.01	.351	
Fe	0.30	1.88		
Ni	0.82	1.75	.563	
Au	High			

Decomposition voltages of electrolyte

Electrolyte	voltage	Electrolyte	Voltage
Zn SO$_4$	2.55		
Cu SO$_4$	1.49		
Ag SO$_4$	.80		
Ag NO$_3$	.70		
Pb NO$_3$	1.52		
Mg SO$_4$			

 New York Jan 29 1930

Electrolytic geophone

Consider two plates each 5 cm diameter and placed 0.5 mm apart. Let the plates be of Zinc and placed in an .005 normal solution of $ZnSO_4$ (.81 gm $ZnSO_4$ to 1 liter of water)

$$R = \frac{2400 \cdot .05}{19.6} = 6.63 \text{ ohms}$$

A potential of 1 volt will produce a current of 150 mA.

Using two plates 7 cm diam 1 volt will produce a current of 300 ma and R = 3.32 ohms

 New York Jan 30 1929

String Galvanometer

Sensitivity

Consider a silver strip .0005" x .003" (.00125 cm x .0075 cm) length 10 cm between supports

Vibration frequency of string

$$n = \frac{1}{2l}\sqrt{\frac{T}{M}}$$

where n = frequency, l = length, T = tension and M = mass per cm length.

using n = 100, l = 10 cm, M (for above strip) = 75·10⁻⁶ gm

$$T = 4 n^2 l^2 M$$

$$= 4 \cdot 10000 \cdot 100 \cdot 75 \cdot 10^{-6}$$

$$= 300 \text{ dynes}$$

Force to displace center of string (a 1" length) laterally $F = 2T \tan\theta$

$F = 2T\, d/375$ (d in mm)

$F = 16\, d \qquad d = F/16$

Consider current of .001 amp passing thru wire located in field of 10000 gauss and 2.5 cm long

$$F_i = Hli = \frac{2.5 \cdot 10000 \cdot .001}{10} = 2.52_m$$

displacement of string will be

$d = \frac{F}{16} = \frac{2.5}{16} = .156$ mm

If magnification is 20,

Displacement of string image

$d_r = 20d = 3.1 \frac{mm}{ma}$

Resistance of ribbon 15 cm

(allowing 5 cm for ends.

$= \rho \frac{l}{a}$

$= \frac{1.5 \cdot 10^{-6} \cdot 15}{9.4 \cdot 10^{-6}} = 2.4$ ohms

Using ribbon .00025" X 003"

d_r = 6.2 mm per milliamp

R = 4.8 ohms

For any string

(Commercial best galv has

sensitivity of 3.6 mm per ma and

R = 2 ohms) - about 6 times a much

a in soil-field)

Strips made by Baker, Newark, of 131 alloy

Sensitivity of combined System

string galv and electrolytic geo

Using data on pps 30 & 32

consider a displacement of .001

mm ($\frac{1}{25000}$ inches) in geophone.

for geophone $\frac{\Delta i}{i} = \frac{\Delta x}{x}$

$\Delta i = \frac{i}{x} \Delta x = \frac{300}{.500} .001$

$\Delta i = .6$ ma

consider efficiency of ⅓ in whole system

$d_r = \frac{6.2 \cdot .6}{3} = 1.24$ mm

For a ground movement of .001 mm

the trace on film will move 1.24 mm

Motion amplification is about

1240

String galvanometer contd

For any string galv

$$D = \frac{i\,H\,L\,M}{10\pi n^2 l d^2 \rho}$$ also

$$D = \frac{M H L \sqrt{W}}{\sqrt{40\pi}\, d\, l^{?} \rho\, n^2 K^{\frac{1}{2}}}$$

where
M = magnification
i = current
H = field strength (magnetic)
L = length of airgap
W = watts (power)
d = diam of wire
l = length " "
ρ = density " "
K = resistivity "
n = frequency (natural)
D = deflection on screen.

For
Gen. Radio Co Type 338 String galv.
l = 11.25 cm (tungsten wire)
d = .00117 cm
r = 65 ohms.

Sensitivity at various frequencies
D.C. volts for 1 mm defl using .00047" tungsten wire

frequency	observed	calc *
60 ~	.0047	.0047
250	.065	.0625
500	.130	.325
1000	1.31	1.31

*Calculated $\frac{e_1}{e_2} = \frac{n_1^2}{n_2^2}$

using .0005" silver wire r = 150 ohms

frequency	calc volts	calc amps
60	.0006	.000040
100	.00166	.000111
250	.0103	.00069
500	.0417	.00278
1000	.1667	.0111

For Cambridge Sci Co
Type C galv.

$l = 7.7$ (see page 34 for symbols)

$d = .0012$ cm

$M = 500$

$n = 100$

$\rho = 2.7$ (aluminum)

$H = 24000$

$L = 3$ cm

using equation & $M = 100$

$$D = \frac{MHLi}{10\pi n^2 l d^2 \rho}$$ for aluminum.

$D = 720000$ mm per amp

$= 720$ mm per ma

$r = 40$ ohms (ea)

For Copper $\rho = 8.9$

$D = 218$ mm per ma

$r = 25$ ohms ea

For Tungsten $\rho = 18.77$

$D = 106$ mm per ma

$r = 36$ ohms.

Baker & Co Inc Newark can furnish above wire
al wire dia .0005" @ $1.65 per ft

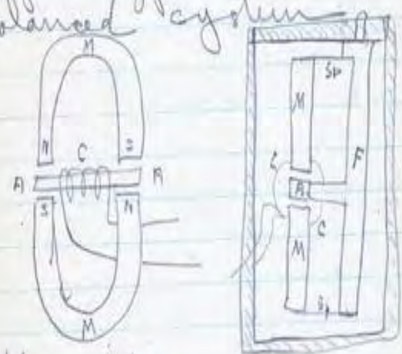
For glass filament as solid

$D = 19000$ mm per ma

$r = 2000$ to 5000 ohms.

[illegible] Feb 20 1930

Magnetic type Seismometer
balanced system



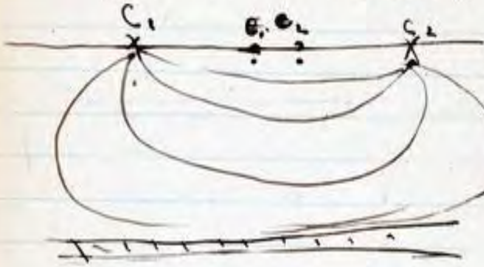
double magnet type

Legend
M = magnet
C = coil
A = armature
F = supporting frame
Sp = flat springs.
(M is mounted on springs
A is mounted rigidly to frame)

single magnet type

Montclair April 4th 1930

Electrical Method.
Measure inductance.



$E_1 - E_2 = E_0 e^{-\alpha t}$

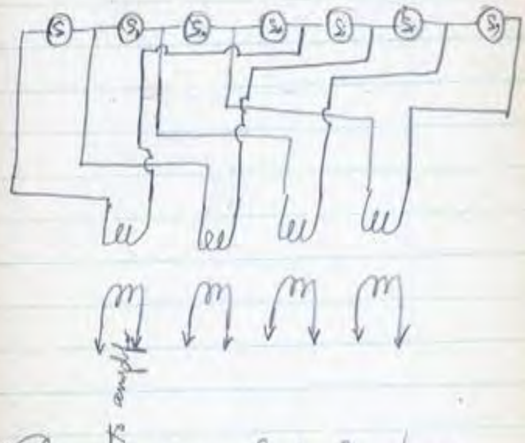
photograph potential curve.

$\alpha = \frac{R}{L}$

Insulating layer will change area of loops ∴ change inductance.
(Roman says inductance calculations difficult)

Dallas Sept 2, 1930

Interference arrangement, using minimum seismometers

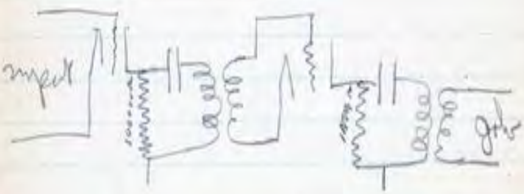


Above is equivalent of four Seismometers on each of four lines.

Streamlined Seismometer

Shape like tortoise shell

Dallas, March 6th 1931



(Load secondary to prevent oscillations)

Should increase sharpness of records.

New York Feb. 5, 1932

Patent Method of planting shot below ground water level. obviates necessity through weathered zone to hard rock. discuss with McD & Salvatori as to inventor. (Pautsch is inventor)

Watkins Glen N.Y.
Feb 15 1952

VELOCITIES OF LONGITUDINAL REFLECTION WAVES,

(approximate) when surface formation is top of :

Pliocene –
$V_{av} = 5200 + .50Z$

Miocene –
$V_{av} = 5600 + .45Z$

Eocene –
$V_{''} = 6400 + .40Z$

Cretaceous –
$V_{''} = 7500 + .35Z$

Permian –
$V_{''} = 8800 + .35Z$

Pennsylvanian –
$V_{''} = 10000 + .45Z$

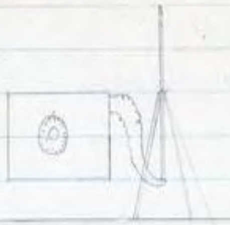
Mississippian –
$V_{''} = 11000 + .60Z$

Not good for values of "Z" (depth from ground water level) greater than 6000 feet.

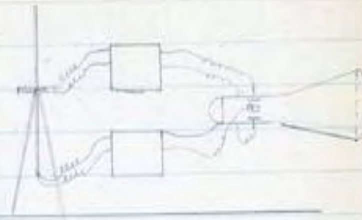
In Southern N.Y. & North PA
used
$V_z = 10730\sqrt{1+.000149Z}$

In Oklahoma & Kansas
used
$V_z = 9000\sqrt{1+.000075Z}$
also $V_z = 9150 + .28Z$

In East Texas
used
$V_z = 6350 + .42Z$

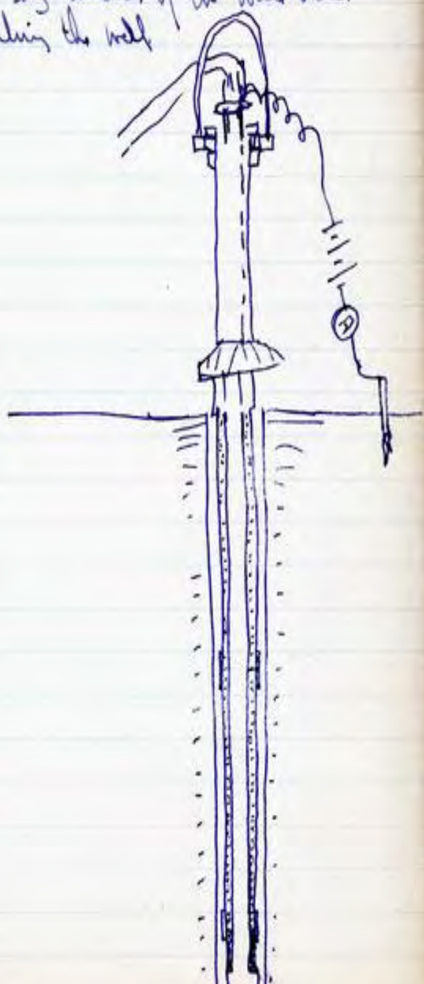


Dallas. Texas August 26 1935



Dallas Tex.
Mar 11 1934

A device for electrically surveying bore holes by means of the drill stem while drilling the well



"Structure of the near infra-red bands of Methane"
Roy Soc Proceedings 153 A.
pp 552-567 Feb 1 1936

[illegible] bands of Methane
Phys Rev [illegible] 1935
3,3 μ & 7,7 μ
2,3 μ
alb 2 cm used for 3,3 & 7,7.
bands an 6 cm used for 2,3 [illegible]

Austin — April 20 1938

Absorption spectra of gases

from Investigations of Infrared spectra - Coblentz

Used cell 6.3 cm long press 750 mm 22°C for methane

Used cell 57 cm long 745 mm 23°C for Ethane

Used cell 57 cm long 754 mm 22°C for Butane,

Liquid cells used in these experiments were 0.15 mm thick generally but sometimes only 0.01 mm in thick as in the case of aniline

Methane Absorption Bands

wave length μ	Per cent transmission
2.35	42 %
3.31	37.7 %
7.7	30.6 %

See fig 12 page 166

Ethane Absorption bands.

Wave length	% transm
2.36	82,2
3.39	91,0
6.83-(6.80)	11.9
11.94	94.7
12.2	
12.5	52.
13.2	

See fig 15 p 169 curve b

Butane Absorption bands

wave length	% transmission
2,4	85,1
3,42	22,
4,5	92,7
5,7	69,3
6,89	18,8
7,8	63,7
8,3	34,1
8,9	32,2
9,6	
9,97	
10,5	
11,2	
12,	50,
13,3	
14,5	

See fig 16 p170

Investigations of Infra-Red Spectra
- W. W. Coblentz
Carnegie Institution of Washington
Publication No's 35-65-97.

Infrared absorption spectra of acetylene, Ethylene & Ethane
- Aaron Levin.
Jour of Opt Soc of Am & Review of Sci Instruments
Vol 16. No 3 March 1928

Infra-red Absorption bands of Methane - J P Cooley

Astrophysical Jour LXII No 2
1925

Infra-red Absorption bands of Methane
- Nielsen & Nielsen

Physical review. Vol 48 No 12
Dec 1 1935

Index of refraction of Fluorite

λ_μ	n (I of R)	Observer	Sin I	Angle I
.19881	1.49629	Sarasin	.74814	48°25'48"
.34015	1.44775	"	.72387	46°22'30"
.41012	1.44121	"	.72060	46°06'15" →
.58930	1.43393	Pasch.	.71696	45°48'15"
.700	1.43152	Carvallo	.71591	45°43'03"
.878	1.42996	"	.71493	45°38'15"
1.009	1.42904	"	.71452	45°36'15"
1.6206	1.42592	Paschen	.71291	45°28'21"
2.0626	1.42363	"	.71181	45°22'57"
3.1430	1.41704	"	.70852	45°06'51"
4.125	1.40850	"	.70425	44°46'03"
5.0092	1.39902	"	.69901	44°20'57"
5.8932	1.38721	"	.69360	43°50'57"
7.0718	1.36508	43°9' "	.68404	43°09'36"
8.2505	1.34444	"	.67222	42°14'19"
9.4291	1.31612	"	.65806	41°09'09"
.760	1.431		.7155	45°41'20"
.884	1.430		.7150	45°38'36"
1.179	1.428	4.43	.7140	45°33'34"
2.357	1.421		.7105	45°16'33"

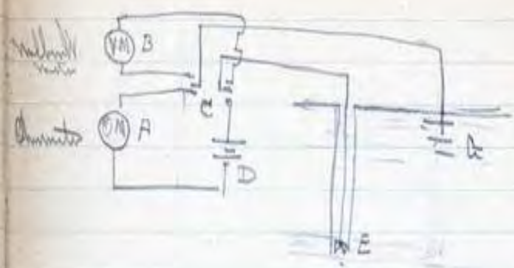
Dallas May 20th 1935

Polarity of battery when using Electrical logging Drill.

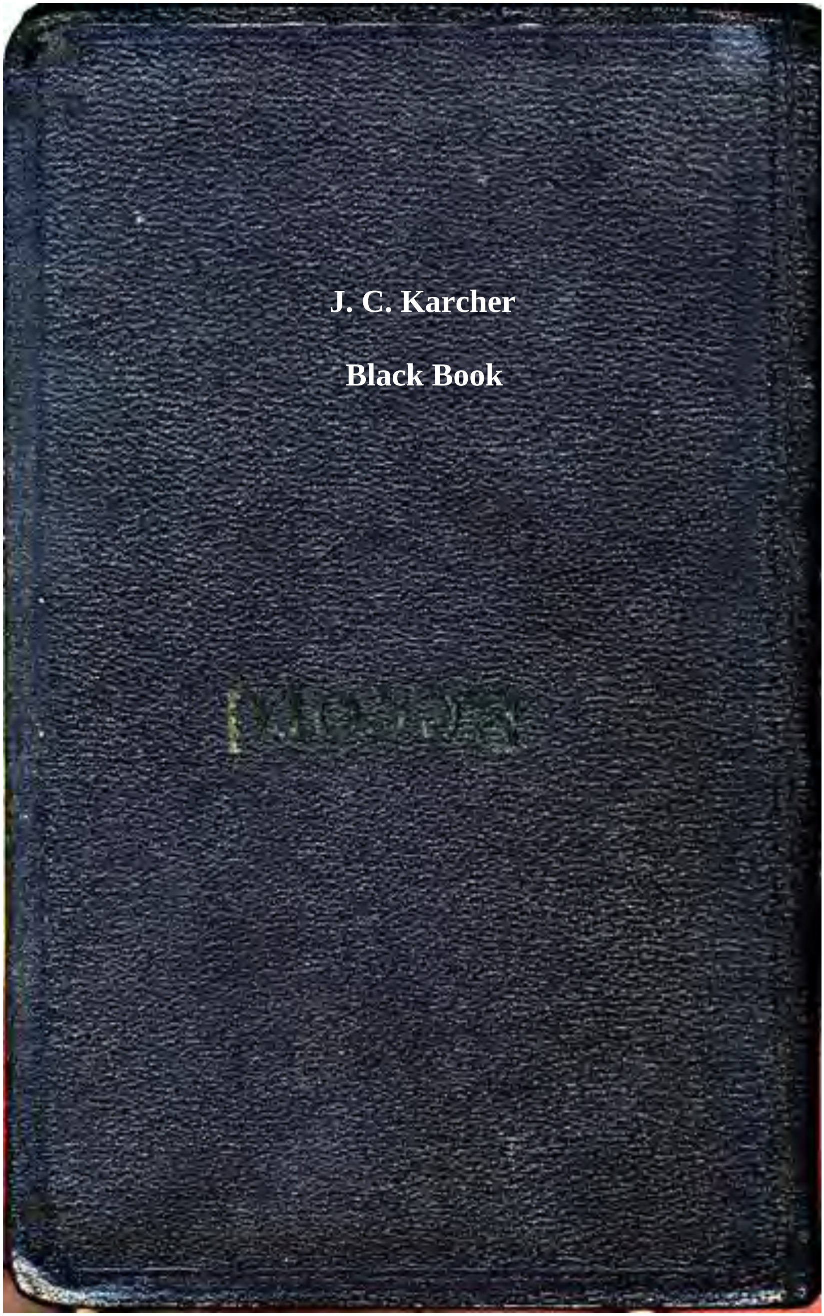
In order to obtain porosity readings on the meter B, it appears that the battery D should be connected (+) to the bit E when the ionic concentration of the drilling fluid is greater than that of the surrounding formation water. For instance if the sands carry fresh water.

If the the formation water has a greater ionic concentration than the drilling fluid the battery D should be connected (−) to the bit E. This is the case when the sands carry salt water.

When the bit is in the more concentrated solution it tends to become positive and causes current to flow from the bit into the ground. By connecting the (+) term. of the battery to the bit the concentration is increased and the effect is accentuated



When the bit is in the lesser concentrated solution (ie when the sands carry salt water) the reverse is true (ie by connecting the (−) pole of the battery to the bit the concentration around the bit is decreased and thereby accentuated


J. C. Karcher
Black Book